SUMMARY OF FINDINGS AND RECOMMENDATIONS

The City of San Diego Police Department has contracted with PB Farradyne (PBF), a Division of Parsons Brinckerhoff Quade & Douglas, Inc., conduct a review of the City's photo enforcement program. The review has been designed to accomplish the following objectives:

- Analysis of the existing program for performance and compliance with original design and specification standards; and
- Reassessment of the program's functions, technologies, and governing procedures for the purposes of identifying all potential improvements and to eliminate problem areas which have resulted in negative publicity that may have adversely affected community support for the program.

This report describes the project's findings, conclusions, and recommendations based on a review of red light running violations and accident data trends, system installations, camera unit setups, photographic data, intersection traffic signal timing and operations, and overall program management and operations.

The report is organized into seven sections, with certain supporting data contained in the report appendices. In this initial report section, the findings and conclusions developed and presented for each of the following report sections are summarized:

- Accidents and Red Light Running
- Photo Enforcement Equipment Installations
- Camera Unit Setups
- Review of Photographic Data
- Traffic Engineering and Traffic Operations Improvements
- Program Management and Policies

ACCIDENTS AND RED LIGHT RUNNING

- The City's photo enforcement program has resulted in a significant reduction in the number of red light running violations at the photo-enforced intersections. The measured reduction in red light running violations at intersections where cameras have been operational for six months varies from 20 percent to nearly 24 percent. Furthermore, the measured reductions in red light running violations have remained about the same as the cameras have been operated for longer periods of time.

  The reduction in red light running violations is generally not as high as reported for other photo enforcement programs.

  Generally, reductions in the number of violations are about the same for photo-enforced intersections where through red light running violations are being monitored and locations where left turn movements are being enforced.

- The City's photo enforcement program has resulted in significant reductions in the number of collisions attributable to red light running at the photo-enforced intersections,

especially on the photo-enforced approaches where an overall reduction of 33 percent has been measured. This is an important finding and indicates that the program, on the whole, has been effective in reducing the number of accidents resulting from red light running at signalized intersections[1].

For intersections where through red light running violations are being monitored, the accident rate for accidents attributable to red light running has declined by 44 percent. For the photo-enforced approaches only at these intersections, the reduction in collisions is an impressive 60 percent.

For intersections where left turn red light running violations are being monitored, the accident rate for accidents attributable to red light running has declined by 20 percent. For the photo-enforced approaches only at these intersections, the number of collisions due to red light running dropped by only 12 percent, less than for all intersection approaches.

Overall, the analysis of the accident data indicates that the photo enforcement program has generated significant reductions in the number of accidents attributable to red light running. The accident rate reductions have been highest for intersections where through traffic movements are being monitored.

- The number of accidents attributable to red light running was found to be remarkably low at three photo-enforced intersections: NB Bernardo Drive to WB Rancho Bernardo Drive (1414); SB Harbor Drive to EB Grape Street (1533); and SB Mission Boulevard at Garnet Avenue (1542).

  One of these locations, at North Harbor Drive and Grape Street, has accounted for nearly one-quarter of the recorded violations and citations issued under the City's photo enforcement program. This location has not experienced a high number of accidents attributable to red light running either before or after photo enforcement. Generally, the locations selected for photo enforcement should be intersections where there are higher numbers of collisions resulting from motorists running red lights.

- Overall, the accident rate at the photo-enforced intersections increased by three percent after the installation of the photo enforcement cameras. This finding is not consistent with the program's overall objective of improving traffic safety for the City's motorists.

  The increase in the overall accident rate has resulted directly from an increase in the number of rear end collisions, an increase that has more than offset the reduced number of collisions resulting from motorists running red lights. After photo enforcement, the average rate of rear end accidents increased by 37 percent after photo enforcement.

  Rear end accidents increased by the largest amount, about 62 percent, for enforced through movements. Rear end accidents increased by the least amount, about 19 percent, for non-enforced left turn movements.

  While the rate of rear end collisions increased for the photo-enforced intersections, it was noted that the rate of rear end collisions dropped over time and, for those

intersections where photo enforcement cameras have been in place for about three years, returned to the before enforcement level. This finding, based on limited data, suggests that the increased rate of rear end collisions will not be sustained over time. Additional data is needed to confirm that the increased rate of rear end collisions will not be sustained over time.

PHOTO ENFORCEMENT EQUIPMENT INSTALLATIONS

- Generally at all locations, the "as built" placement of the photo enforcement system improvements do not correspond with the intersection improvement plans, especially with regard to the placement of the vehicle detection loops. At most locations, the "as built" camera pole locations were found to be reasonably consistent with the intersection improvement plans.

  It is an important finding that the intersection improvement plans were not prepared by a California Registered Civil or Electrical Engineer and were not subject to the City's plan check, permitting, and inspection procedures. Related to this finding, "as built" plans were not prepared for any of the 19 photo-enforced intersections.

  It is an important recommendation of this report that the City should require that any further photo enforcement system installations be done in accordance with the City's plan check, permitting, and inspection procedures; that the intersection improvement plans be prepared by a California Registered Engineer; and that "as built" plans be prepared and then maintained to reflect any subsequent upgrades or adjustments.

- It is a general recommendation, the most important one of the project report, that the City not re-start its photo enforcement program without the relocation of the vehicle detection loops to locations where the first photograph is taken immediately before the vehicle crosses the stop line, instead of after the vehicle has already entered the intersection. This approach will eliminate the uncertainties associated with the measurement of vehicle speeds using the vehicle detection loop pairs.

  The implementation of this recommendation will require that the vehicle detection loops are re-cut and that camera unit settings be adjusted at 18 intersections. Vehicle detection required for the operation of the traffic signals may also need to be installed at selected locations. At these locations, it is recommended that video-based vehicle detection systems be employed for traffic signal control purposes.

  The estimated cost for re-cutting the photo enforcement loops and for installing video detection equipment at 18 intersections is $220,000.

- In conjunction with the relocation of the vehicle detection loops, it is recommended that enhanced advanced warning signs be installed at each intersection to supplement the standard photo enforcement signs currently installed at the photo-enforced intersections. The estimated cost for the purchase and installation of the enhanced advance warning signs for the 19 photo-enforced approaches is $3,800, assuming that the signs can be installed on existing poles.

- The vehicle detection loop configuration employed at 18 of the 19 photo-enforced intersections requires that the time when motorists entered the intersection against a red light is estimated based on the measured speed over the vehicle detection loops. Errors in the estimated vehicle speeds may result from this configuration as well as from the inherent operating characteristics of inductive vehicle detection loops.

  The possible errors resulting from the loop configuration and loop operating characteristics have been analyzed. From the analysis, it appears that the grace periods being applied before citations are issued are sufficiently long to compensate for any errors and that the City should be confident that all citations issued to date under the photo enforcement program have been properly issued with regard to possible errors resulting from the configuration of the vehicle detection loops.

CAMERA UNIT SETUPS

- Besides a few difficulties encountered during the inspection and testing of camera systems as described in the report, the camera equipment appeared to function properly and be well maintained. Appropriate camera unit settings were generally in place for all locations.

- The loop-to-loop pitch values, as input to the camera units at the 19 intersections, generally correspond very closely with the measured pitch dimensions. Small differences, up to one percent, were found between the camera unit and measured pitch values at selected locations. Any difference up to one percent should not be viewed as a significant difference and is well within the tolerances for cutting loops and for vehicle detection as vehicles pass over loops.

  At certain locations, it is difficult to determine with certainty what pitch measurement should be used for the camera unit setting due to the skewed installation of the vehicle detection loops and skewed intersection geometries. At these locations, it was necessary to make judgments regarding the expected paths of motor vehicles entering the intersection.

  The pitch measurements will continue to be important when the vehicle detection loops are re-located, as they will be the basis for established vehicle speeds for the application of the minimum speed threshold, but not nearly as critical as under the current configurations.

  The City should establish a written policy regarding pitch measurements and how pitch measurements are to be made where there are unusual or irregular loop configurations. For all cases, the policy should state that the shortest pitch dimension, where more than one pitch measurement may be applicable, should always be used for the camera unit setting (that is, in order that the measurement be in the favor of the motorist).

- At certain locations, two sets of loops are in place making it difficult to determine with certainty which set of loops are currently operational for the photo enforcement system. In the future, as built drawings should be maintained so that the operational loops can be readily identified. Abandoned loops should be intentionally cut on two sides so that it is

clear that the loops have been abandoned as well as to eliminate any possibility of loop-to-loop crosstalk. Crosstalk between active loops and abandoned loops that have not been cut is possible and can result in unreliable loop detector performance.

- The delay time represents a "grace" period for motorists entering the intersection against a red traffic signal indication. The actual grace periods being applied the 19 photo-enforced intersections, except for the A Street/10th Street intersection, varies according to vehicle speed and the distance of the leading edge of the second loop from the stop line. In other words, the grace period is not consistent from intersection to intersection nor, for the most part, from vehicle to vehicle. The actual grace times may be determined by examining the tables developed by LM/ACS for each intersection and used to determine whether a citation should be issued for each photographed violation. From an examination of these tables, the actual grace periods applied in issuing citations vary from 0.25 seconds to 0.57 seconds.

  For the future when the vehicle detection loops have been re-located in accordance with the manufacturer's recommended configuration and industry practice, the City needs to establish its policy for delay times at photo-enforced intersections. Delay times ranging between 0.3 seconds and 0.5 seconds are typically used.

REVIEW OF PHOTOGRAPHIC DATA

- A total of 83,931 citations have been issued to motorists under the City's photo enforcement program. About one quarter of the citations have been issued for violations at one intersection, at North Harbor Drive and Grape Street, where the photo enforcement cameras monitor left turn movements.

  Citations are issued for approximately 36 percent of the possible violations recorded at the photo-enforced intersections. Accounting for the number of possible violations that are discarded after the grace period time allowances are applied, the percentage of recorded violations that are converted to citations is increased to 43 percent.

  The percent of citations issued varies from a low level of about 21 percent for the Imperial Avenue/Euclid Street (1484) and Miramar Road/Camino Ruiz (1534) intersections to a high level of about 54 percent at the intersection of Mission Boulevard and Garnet Avenue (1542). More than 50 percent of the violations recorded at the College Avenue/Montezuma Road (1462) and Black Mountain Road/Gemini Avenue (1551) intersections are cited.

- The largest number of citations not issued, amounting to 16.3 percent of the possible violations, is for no front license plate. This percentage is consistent with the levels reported by other photo enforcement programs. A portion of these violations could be cited with the installation of nearside cameras that are able to photograph the rear license plates of red light runners. With nearside cameras at each photo-enforced intersection, the number of issued citations each month would increase by approximately seven percent.

- Approximately 14 percent of the possible violations are discarded due to lighting and optical problems where the driver's face is not clearly visible in the second photograph as required by the California Vehicle Code. Auxiliary flash units could be installed to provide additional vehicle interior lighting at photo-enforced intersections where dark vehicle interiors are a recurring problem. It is also possible that polarizing filters could be employed at additional locations, especially for intersection approaches that are oriented east and west, to increase the number of citations issued.

  Approximately 23 percent of the possible violations are not cited because the driver's face, vehicle, or license plate is out of the frame of the photograph or is obstructed. These factors are more common at intersections where double left turn lane movements are being enforced.

  The City and its contractor, LM/ACS, should address these various problems at the photo-enforced intersections, one at a time, using photographic data to analyze the nature of problems, to develop improvement strategies, and to evaluate whether the improvements have been effective.

- The City should review the other photo enforcement systems that are currently being deployed in California and other States. New photo enforcement technologies have become available over the past five years, most notably technologies that employ digital camera equipment where photographic data, including streamed video clips, may be immediately downloaded for processing using T-1 telephone line or microwave communications. Additionally, photo enforcement systems that use non-intrusive vehicle detection methods as well as systems that employ overhead camera placements and floodlighting equipment as an alternative to the curb-based placements used for the San Diego program are being tested by cities throughout California and elsewhere.

TRAFFIC ENGINEERING AND TRAFFIC OPERATIONS IMPROVEMENTS

- It was determined that the actual yellow change intervals at 17 of the photo-enforced intersections were equal to or higher than yellow times calculated using the City's guidelines. The intersections where the yellow times were lower than the City's guideline were at Harbor Drive and 32nd Street (4.5 seconds actual versus 4.7 seconds per City's guideline) and Black Mountain Road and Gemini Avenue (3.7 seconds actual versus 4.2 seconds per City's guideline).

  Speed surveys should be done for the approaches at the two intersections where the yellow times did not meet the City's guidelines in order to re-calculate the yellow times for these intersections. The yellow times should be adjusted accordingly when the yellow times have been re-calculated.

- SB 667 requires that the yellow change intervals be based on the Caltrans Traffic Manual. The yellow change intervals at 10 of the 19 photo-enforced intersections are shorter than the yellow times specified by the Caltrans Traffic Manual. Eight of the yellow change intervals that are not in compliance are for left turns where the Caltrans Traffic Manual specifies a minimum yellow time of 3.1 seconds, as opposed to 3.0 seconds per the City guidelines.

Before the photo enforcement systems is re-started, it will be necessary to adjust the yellow change intervals to be in compliance with the Caltrans Traffic Manual, including any changes being implemented or considered for the Caltrans Traffic Manual that may be required for compliance with the Millennium MUTCD.

- It is a key recommendation of this review that the City's Police Department work more closely with the City's Traffic Engineering Department to develop a comprehensive methodology for the deployment of photo enforcement cameras in the City, building upon the Traffic Engineering Department's on-going traffic safety improvement program and resulting in the future deployment of photo enforcement cameras within the context of an overall traffic safety improvement program; to ensure that the yellow change intervals at photo-enforced intersections are adjusted in accordance with the City's guidelines; to coordinate photo enforcement system installations so that vehicle detection is provided for both photo enforcement and traffic signal control applications without one adversely impacting the other; and to reinforce the mutual interests and capabilities of the City's law enforcement and traffic engineering professionals to develop an overall traffic safety improvement program for the City that is a model for other cities and agencies throughout California.

PROGRAM MANAGEMENT AND POLICIES

- From the project team observations and audits, the procedures and methods applied by LM/ACS are generally proper and being applied in a timely manner consistent with the requirements of the California Vehicle Code. The procedures and methods are designed to ensure the chain of evidence for each recorded violation so that backup data and documentation can be easily retrieved when needed. Internal quality control is maintained by a double blind internal review of each violation. Additionally, all citations prepared by LM/ACS are reviewed and approved by the Police Department before they are issued.

  It is noted that LM/ACS provides similar system operation and citation processing services to a number of other cities in California and elsewhere using, for the most part, the same internal procedures and methods.

- LM/ACS has carried out the required equipment servicing and inspection functions since the system startup. LM/ACS has maintained service and inspection logs for the photo enforcement equipment installed at the 19 intersections from the period of their installation to the time at which the cameras were turned off in June 2001.

- The internal procedures and methods used by the Police Department and LM/ACS should be clearly documented in writing. In particular, the procedures should address in detail the following items:

  - Guidelines to be applied for issuing a citation, in other words, a very specific definition of what constitutes a red light running violation;

- Citation review and approval requirements, including provisions for the procedure to be used when the time to review is shortened, traffic officers are not available to conduct the reviews, or the number of citations is larger than usual; and

- Quality assurance audits, to be conducted by trained traffic officers for randomly selected sample of recorded violations on a periodic basis.

- The following elements are recommended as the basis for re-starting the City's photo enforcement program and for its development as an effective element of a comprehensive traffic safety improvement program.

  - Traffic Safety Partnership. The photo enforcement should not be viewed in isolation and needs to be viewed as one element of an overall traffic safety improvement program. A Coordinating Committee, under the leadership of the City's Police Department and consisting of representatives from the Traffic Engineering Department, Public Works Department, Traffic Courts, City Attorney's Office, selected community groups, and outside agencies concerned with traffic safety such as Caltrans and the Auto Club should be established and meet on a regular basis, monthly to start with but not less often than quarterly. Regular agenda items should be the review of the violations and citations issued data with a discussion of any changes or trends noted. Discussion should be encouraged on whether program objectives are being met through the deployment of photo enforcement cameras or whether alternative measures should be applied.

  - Program Objectives. The program objectives need to be defined as clearly as possible as an early step for moving forward. It is clear that the primary objective of any red light running photo enforcement program, including the City's program, is the reduction of collisions at signalized intersections resulting from red light running.

    Importantly, the program objectives should address specific operational objectives as well as objectives related to financial performance. The latter is especially important and questions such as whether or not each location where photo enforcement equipment is installed needs to be self-sustaining need to be addressed and incorporated into the statement of operational objectives. Additionally, the program objectives should support the development of a formula for the use of the revenues generated by the photo enforcement program, such as by the allocation of "x" percent of the program revenue for on-going accident data analysis and reporting; "y" percent for the development and maintenance of a public awareness and information campaign; and "z" percent for the funding or partial funding of other traffic safety improvements, not related to accidents caused by red light running violations.

  - Re-Engineered Photo Enforcement Equipment Installations. It is it is necessary that the vehicle detection loops used to trigger the photo enforcement cameras at 18 of the 19 photo-enforced intersections be re-located. At the same time, the City should consider the installation of enhanced advanced warning signs and

investigate camera equipment upgrades, such as nearside cameras and auxiliary flashes, for selected locations.

- Public Awareness and Information Campaign.

- City Design and Construction Review. For any future modifications, changes, or expansion to the photo enforcement installations, the City's normal design review and construction inspection procedures should be in place and carried out. Installation plans should be prepared by a registered California Civil or Electrical Engineer.

- On-Going Problem Identification and Analysis. The on-going analysis of the violations and citations issued data provided by the photo enforcement program as well as on-going analysis of intersection accident rates by type of accident together with community inputs are the foundation of a comprehensive traffic safety improvement program.

- It is recommended that the photo enforcement program be maintained at locations and expanded to new locations on the following basis:

  - To provide uniform coverage throughout the City according to a pre-determined minimum coverage standard; or

  - For intersection approaches where the accident rate for accidents caused by red light running exceeds a pre-determined minimum threshold standard; and

  - For intersection approaches meeting one of the above standards where installation of the photo enforcement equipment is feasible and can be expected to meet or exceed the pre-determined minimum percent cited standard; or

  - For intersection approaches where a diagnostic team review has determined that photo enforcement should be effective to mitigate a particular traffic safety hazard, even through the intersection approach may not be in compliance with one or both of the above standards.

[1] Accidents, especially those involving injuries, are relatively rare events statistically. Large, long-term data sets are required for a statistical analysis of accurate trends. The findings and conclusions on accidents should be viewed as accurate indications based on the limited data available.